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ABSTRACT

There is a great deal of uncertainty about the graduate education of scientists and engineers. Students are worried about employment opportunities, institutions worry about the quality and quantity of their future graduate programs, and the government worries about an adequate supply of trained manpower for the future. Added to these worries are the increasing suspicion of science on the part of the young, increased employment problems for scientists and engineers, and a limitation of students in the graduate programs, ostensibly for financial reasons. All this has pushed the production of Ph.D.'s downwards. Thirty percent of the doctorates in science are involved in non-academic research, and in this area the Federal Government, the main supplier of funds, has been retrenching. Though private support for R&D has increased, this trend may not continue. The employment picture of scientists and engineers in higher education will depend on future enrollments. According to projections made by the N.S.F., doctorate production will increase by 60 percent over the next 10 years, graduate enrollment in the sciences and engineering will increase from 60 to 65 percent, R&D expenditures will probably remain at 2.8 percent of the G.N.P., and the supply of scientists and engineers with the Ph.D. will probably be slightly larger that the demand, though this will vary and be more pronounced in engineering. (AF)

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PROJECTIONS ON THE DOCTORAL POPULATION*

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DR. CHARLES E. FALK: Thank you, Mina.

Before I make my remarks, I would like to point out to you that the title of my presentation from one point of view is an overstatement, and from another point of view, an understatement. It is essentially an overstatement in that it implies that I will talk about all types of doctorates. And because of my own interest and my activities at the National Science Foundation, I will limit my remarks to doctorates in the field of science and engineering which I will treat in a comprehensive way, including the life sciences, and physical sciences, social sciences, mathematics, and engineering.

It is an understatement from the point of view that it talks about the doctorate population. At

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least I had the implication there that I was going to be talking mainly about the supply of doctorates, the future supply. What, however, I would like to do is to discuss with you the whole question of the relationship--or the likely relationship--of the future supply of doctorates in science, and I will use the word "science" now as essentially meaning science and engineering, and their likely utilization and the question of whether there are balances and imbalances.

Now this question, as all of you are very much aware of, and the fact that you have a session here today is a direct indication it has become more urgent during the last two years and I think becomes more urgent almost week by week. It has an urgency for different groups from different points of view; the new doctor or the graduate student being in his educational field that will lead to a doctorate is considerably worried about his employment opportunities. And as was pointed out before, frequently this is not a question of will there be an employment opportunity, but what type of employment opportunity will there exist, and does it match his own aspirations?

Going back even further in the educational

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system, your science major or your potential science major and your baccalaureate in science worries about this aspect because he has to make a decision after he gets his baccalaureate whether he should continue to pursue a career in science leading to an advanced degree.

The academic institutions and the various departments have great concern about this question because the answer, vague that it may be, is required for them to do any kind of meaningful planning with respect to the quality and the quantity of their future graduate programs.

And, finally, all of us, and especially those of us in the government of course worry about it from the point of view as to whether there will be an adequate supply of highly trained personnel--in this case doctorates--to really meet the needs of society.

So, from every point of view, this problem is an urgent one and unfortunately it is one which is in a state of transition which makes it somewhat difficult to make projections.

Now, in making these projections, a number of factors have to be taken into consideration. I believe it might be worthwhile just to mention a few of these

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because they will indicate to you why it is so difficult to make projections at this point and why projections have to be essentially dynamic; by that I mean they have to be repeated at fairly short intervals because the situation is changing.

If we look at the production of doctorates there are, of course, the what I would call the usual factors, the factors which always are taken into consideration. In the first place, demographic factors; what are the number of people in the age group which could potentially go to graduate school and get a doctorate?

And, in second place, the question of what fraction of this age group will not only finish college, but then go on to graduate school and actually get doctorates? And as you know, that fraction has increased over the last couple of decades rather steadily.

It used to be that these two factors were fairly well known. The demographic one certainly is clear-cut because people who are going to get doctorates, at least during the next ten years, are not only born, they are already in the pipeline of the school system, and the rates of going to these advanced degrees have shown some very steady trends.

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But the situation is very different now and has been different for the last couple of years.

And some other factors have crept in which can and will become increasingly important and are much more difficult to predict.

We have seen an increasing distrust of science by students and, I think, by our society as a whole because they have become aware of some of the problems which are associated with technology and these problems have, at least in my opinion, taken on an overwhelming aspect so that people too easily forget the benefits which have come out of science and technology and only look at the problems. But the net result, nevertheless, has been that this has affected students' choices whether they wanted to go into a career of science.

There has been during the last couple of years a considerable amount of publicity--and, incidentally, some of it very valid--about the employment opportunities for scientists and engineers, and Mike Pelczar mentioned some of these to you. They have been somewhat exaggerated, I believe, in that they mention mostly unemployment aspects which really we do not have too much evidence that there is a major problem in unemployment.

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But as was mentioned before, the problem seems to be a mismatch between aspirations of students, new doctorates, and employment opportunities.

For example, in the last register of scientists which we carried out last spring, we have the results now, and while this doesn't cover the whole universe, as you know we get about a 60 percent response rate. But of those 60 percent that responded, the unemployment rate which was listed by respondents in the sciences was on the order of 1 percent in the doctorate population. This has been borne out, I think, in previous surveys. So the absolutely unemployed ones, the number of unemployed ones is not very large.

Now, there is another question about whether people are underemployed, namely that they are not fully using or not using their graduate training, and that is a much more difficult one to answer. But I think some information on that was produced last year by the National Academy of Science and I think they are going to re-do that survey again this year so at least we will know about new doctorates, to what extent the departmental chairmen, at least, feel that the Ph.Ds have been underemployed.

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A third factor is, of course, one which you are very much aware of and that is that quite a few graduate departments are reducing the number of first year graduate students which they are willing to accept, and this is done for a variety of reasons.

In some cases it is a question of the fact that the faculty worries about the employment opportunities of the doctorates they might be turning out. In other cases, it is simply a matter of finances. Graduate education is the most expensive part of higher education and fiscal stringencies at a university might require, and do require in some cases that the graduate program be cut down somewhat.

And finally, and this to me is still somewhat surprising, some departments cut down their first year enrollment because they do not see their way clear to paying stipends to the graduate students which will be coming in during their whole career.

The reason I say this is surprising to me, it seems to me this is an artificial limitation because if the student is qualified and willing to pay his own way, why bar him from coming to a university? But that has happened and I think partially this is the

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result of a pattern which has developed during the last 15 years in which it has been fairly easy to get graduate support for students.

Now, all these factors unfortunately--or fortunately, let's not make a judgment--but all these factors have a tendency to push the production of Ph.Ds downward. And actually this is a phenomenon which is not completely new, as I can show you in a couple of slides. Can we dim the lights a little?

(Showing slide) This is a chart of first year enrollment for advanced degrees in science and engineering as the percent of all fields with the top line essentially being the cumulative curve, and the scale is from 1960 to 1969. And as you can see, starting about 1964, that percentage has been going down, and while in the last year it may have evened out for one year, it is not clear at all that this is not somewhat artificial and that this decline might continue. So this phenomena, for one reason or another, of having fewer students pick science as a subject of their graduate study has been experienced for the last four or five years.

(Showing slide) This graph here is

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essentially a graph of baccalaureate degrees in selected fields of science and, incidentally, while the previous graph was a percent of the total, these are absolute numbers. And you can see that even in absolute terms in some fields, especially the physical sciences, there has been a flattening off of the number of baccalaureate degrees which are being awarded, while in other sciences such as social sciences it has increased drastically.

If one would plot the same plot which I showed you for the first year enrollment, namely what percent of the total they are, the total also of baccalaureate, those who get science degrees as compared with total degrees has been slowly decreasing.

So, these are some of the factors which have to be taken into consideration in worrying about future availability of Ph.Ds.

And I want to emphasize here that, of course, what we see today would probably only have an effect four to six years from now with respect to either baccalaureate or first year students.

Now, from the point of view of utilization of doctorates, we also have several phenomena which have really been the basic cause for some of the difficulties

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during the last two years.

In the first place, about 30 percent of the doctorates in science are involved in non-academic research and development. And the nature of this research and development has been changing because of the following reason: Two-thirds of the R and D funds come from the Federal Government. The priorities in the Federal Government for R and D are changing. The absolute amount of R and D which the Government is making available has been changing in a downward direction.

For example, in 1967 it amounted to $17.1 billion, and in 1969 we were down to $16.6. This might not seem like a very big decrease, it is only about 2.5 percent, but really if you translate that in terms of real dollars, then that decrease is a 13 percent decrease over a period of two years. If this trend continues this will affect the number of doctorates who can be active in research and development activities.

Now, the non-Federal component of R and D--and I am talking here about the sources of funds--has been increasing and has continued to increase despite this drop-off by the Government. But there is a great question, will they continue to do so?

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In the first place, the economy has changed in the last year, it has not been as rosy as it was before, and R and D programs are easy prey to budget-cutting, because the results are really long-range results most of the time.

Furthermore, at least on the basis of anecdotal information, I am under the impression that many industrial firms maintain and actually even increase the amount of R and D funds which they made available, primarily to keep their research teams together with the hope that the trend, the decreasing trend of the Government would reverse itself and that they would then be in a good position to apply and utilize Governmental funds.

So, taking this one aspect of utilization in research and development in consideration, we are in a period where there have been downward trends, and one of the big items of uncertainty is how long will this downward trend continue.

Incidentally, there is one factor which works opposite to what I have just said and that is the question of how many R and D dollars are required per R and D scientist?

(Showing slide) The next graph gives you

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an idea of what has happened there. You are looking at a period going from 1958 to 1968. The solid line has been the cost per R and D scientist and not Ph.D., and you can see it has increased steadily. But the interesting fact is that if you look at that in terms of 1965 dollars, and the dotted line indicates that, over the last--since 1965 just about, in terms of constant dollars and not taking inflation into consideration, the cost per scientist has been pretty level after an almost continuous rise in the previous decade.

The reason is not that difficult to guess: When things get tight, most institutions try to preserve their manpower and take their cuts in non-human categories; equipment, travel, publication costs, supplies and material, and apparently this has had the effect of flattening out this curve of cost per R and D scientist.

Now, if this continues in the future, then you might have a very different number of scientists, doctorates, involved in R and D than if it would resume its increase.

Of course, I must admit that my feeling is this flattening out can't go on forever. You can just cut things like travel and equipment for so long and then,

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in order to have any type of a decent R and D program, one has to start increasing those again. So my guess would be that this curve will start increasing again, but certainly not at the rate it was increasing in that period there before it flattened out.

Another element of the utilization is the utilization of doctorates in academia and here, of course, the utilization is directly related to the number of future enrollments. If the enrollments continue to go up, then the number of doctorates employed by universities will also go up.

But the big question mark--and I will come back to that in a minute--is by how much will they go up over the next ten years, especially if you take in consideration some of the factors I mentioned which are related to the production of scientists which have a tendency to depress enrollment, not in absolute terms but in relative terms. Then one could also at least estimate that maybe the utilization of scientists in universities will not be as large in the future as one might have anticipated five to ten years ago.

This is especially significant if one takes a look at the distribution of Ph.D. scientists and

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engineers and realize, as you can see in this pie chart here, that 60 percent of them in 1968 were indeed employed by universities and colleges.

In other words, the question of enrollment is going to have a very major effect on how many doctorates will be employed in the future.

Now, with these general remarks then let me talk about actual projections. Projections are precarious--to make projections is precarious at best and I think at this time maybe one could consider oneself to be insane to even try to make projections in terms of all these uncertainties which I have mentioned here. Nevertheless, they have to be made because at least one should have available a set of projections on a basis of different assumptions which can then be used by those who have to make long-range plans such as universities any way they want to.

As long as the assumptions are clearly stated, they can pick out those with which they feel they are mostly in agreement or which in their judgment are the ones most likely to happen.

But also as I indicated before, these projections have to be made frequently and have to be

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changed because the situation is changing.

Now, about 18 months ago the National Science Foundation did try to make a projection of what the situation might be like in 1980 and this was reported in N.S.F. Publication 69-37, and I suspect many of you are familiar with that.

However, during the last six months we have looked at these projections again in view of the changing circumstances and have pulled in somewhat different assumptions and also have used, at least in one case, somewhat different methodology. What I would like to do is tell you a little bit about those, but I would like to make one qualification.

You are really the first people who are going to hear about this because we just barely finished them in time for this meeting. They haven't been completely doublechecked and there are one or two aspects of it that you might want to look at our assumptions again. But I am sufficiently confident that at least on the basis of the assumptions we made, that these projections are valid; that I have no qualms talking to you about them today.

Incidentally, these projections were not

made only for the total group of doctorates, which was what we did almost two years ago, but also for doctorates in particular areas of science. So this will be a bit of new information at least.

Well, what were some of the changes which we felt we had to make since we did this two years ago? From the point of view of supply, two years ago we used essentially the enrollment projections which were developed by the Center for Educational Statistics of the Office of Education. However, now we feel that these might be somewhat on the high side because they are based essentially on regression equations covering the last ten-year period and so essentially, in our opinion at least, do not place enough emphasis on what has been happening in recent years. Consequently, we developed our own model, and while I don't want to bore you with too much methodology, you ought to have at least a rough idea of what we did.

We essentially established a set of ratios and the growth rate in those ratios, and these were the following: We got the ratio of bachelor's in science and engineering to total bachelor's. We got ratios of first year graduate enrollment in science and engineering to bachelor's of science and engineering the year before.

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Then we went from first year to total enrollment and from total enrollment we then went finally to the Ph.Ds.

In each case we developed certain growth rates for these ratios, but we only used the information available for the last six years. And then since we felt that even that would give us too optimistic an answer, we went in the last three years quite heavily by really using the model and making projections for those three years and then adjusting the actual data which are available from the Office of Education.

So that we have used the model which uses a six-year span as the basis with extra special emphasis on the last three years.

The results are the following, that as we see it now the number of doctorates produced over the next ten years will be about eight percent less than what we thought it would have been two years ago. This still, incidentally, means that the doctorate production in science and engineering will increase by 60 percent over what it is now.

The change in the graduate enrollment for science and engineering was more pronounced; namely that

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as we see it now, it would be about 35 percent smaller than what we had assumed two years ago, and this is due directly to some of the factors which you could see in the earlier graphs, namely that the enrollments on a relative scale at least have been going down and are going down, and consequently we now project graduate enrollment for science and engineering to increase also by about 60 to 65 percent during the next decade as compared to almost 100 percent increase which was projected at an earlier date.

So these are the changes which in our projections affect the supply.

With respect to the utilization, the last time we took growth rates of R and D funding, both Governmental and non-Governmental, and made a number of assumptions based on what they had been essentially during a ten-year period. Now, the last ten-year period was a pretty good one and we did this with the expectation that maybe the situation as far as the Federal spending especially was concerned would revert. It has not reverted and consequently while last time, when you added these up, we got an R and D dollar figure for 1980 which was somewhere between 3.4 and 4.4 percent of GNP. This

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time we reduced this to a figure of 2.8 percent of GNP or 3 percent of GNP, we used both assumptions.

To give you an indication of why we picked those two. In 1967 the ratio of R and D expenditures in the United States to GNP was 3 percent. It has now declined, in 1969 at least, to 2.8 percent, so we essentially are more pessimistic in saying that at the worst it will remain at the same relative level with respect to GNP that it is now, and at best it might go back to what it was in 1967.

Now, this of course, doesn't mean that the R and D funds which will be available will be going down, because GNP is expected to go up and here we used the estimates which have been made by the Council of Economic Advisors for the National Planning Organization and other groups which are pretty expert at doing this. All of them still assume a 4 percent increase, annual increase, over the next decade. If anything, this might be a little on the high side, but we had no reason to lower it.

With respect to faculty, the faculty, of course, we looked at again from the point of view of a graduate faculty, a faculty in four-year institutions, faculty in two-year institutions and since the enrollments,

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at least in graduate enrollments, would be down according to our projection, that number is down somewhat, too.

The undergraduate enrollment, we still felt we had no better way of doing it than O.E. which has a very good handle on that, so we used the same O.E. projections which we used two years ago.

Well, then what did we do with the assumptions? We calculated the supply as I indicated to you before, and then we went into the question of utilization.

In calculating our utilization this time, of course, we had the difficulty of not just doing it for the total body of doctorates, but we had to do it by field or by area of science.

In the academic sector we used enrollment as a basis. In a graduate school this was simple because we simply used the enrollment by field of science for which there are data available, and made the utilization of doctorates proportional to that.

In undergraduate institutions we saw no better way of doing it than to assume that a split by area of science would be about the same as it is now. Whether this will really be the case, I don't know, but we saw no other way of doing it.

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We did, however, make the following assumption: During the next ten years new Ph.Ds will be required by academic institutions for two reasons. In the first place, there will be attrition from the present faculty due to death and retirement. In the second place, the institutions are going to grow.

Now, instead of using the same proportion of Ph. Ds to total faculty that is in existence now for these replacements of incremental faculty groups, we assumed that 95 percent of the newly hired faculty in graduate schools would be faculty with Ph.Ds as compared roughly to about 85 percent at the present time; 85 percent of graduate faculty has Ph.Ds.

With respect to four-year colleges, at the present time the situation is roughly that 50 percent of the faculty has doctorates.

We assumed that as far as new faculty was concerned, that would increase to 75 percent simply on the basis that Ph.Ds would be more readily available.

And with respect to two-year colleges where the ratio of Ph.Ds to total faculty now is only about 10 percent, we assumed that new hires, the ratio would be 40 percent.

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With respect to non-academic sectors of utilization and employment we used, as I mentioned before, the 2.8 and 3 percent ratio to GNP to get R and D dollars. We then split those among the various sectors according to relationships which have been evident during the last five years.

We calculated the cost per scientist and therefore then the cost of R and D scientists taking, again, some of the past factors in consideration and came up with a total number of R and D doctorates for 1980.

We then, however, had a job of trying to see now how would they split up among the different areas of science. Here we utilized a study which has just been recently published by the Bureau of Labor Statistics on college-educated workers from 1968 to '80 in which they did a rather careful study trying to predict these by field of science.

Now mind you, these were essentially all scientists and engineers by field of science who would be in industry, in Federal Government and non-profit institutions.

So, again, we had to take ratios of total

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R and D scientists to total scientists and then Ph.D. R and D scientists to total R and D scientists and look at some of the growth rates which have been experienced over the last few years to come up with 1980 figures.

This sounds somewhat involved--and it is--but it is the only way we can really relate some of the existing studies and some of the existing facts to what the situation might be like ten years from now.

We also made an assumption in this sector, namely the non-academic R and D sector about what the situation would be with respect to the incremental number of doctorates who would be hired over the next ten years.

We assumed that the ratio of Ph.Ds to non-Ph.Ds would not be the same as has been in the past, but we used two assumptions to get a range. In one case we assumed that that ratio would increase by ten percent. And the second assumption, the second calculation was that this ratio would increase by 20 percent; again, on the basis that all of our studies and other studies indicated that we would not be in a period of acute shortage of Ph.Ds and on the assumption that therefor the non-academic sector would hire Ph.Ds in some cases to replace people who previously did a job and did not have the

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Ph.D. with people who did have, indeed, the more advanced degree. But as you notice, our increases there aren't nearly as much as we assume for the academic sector because the cost factor gets to be an increasingly important one, especially in the industrial world.

Finally, just as we did the last time, we had to calculate how about those Ph.Ds who are neither in R and D or neither in academia and are involved in other positions? There is a surprising number of those and it has been increasing, even during the 1960 to 1968 period where we had a relative shortage.

We have information from the National Register on these people. We essentially could develop growth rates of the fraction of those people as compared to the total number of Ph.Ds and we increased that ratio, that growth rate, by about 25 percent, again on the assumption that as the Ph.D. market became somewhat softer, more people would go into these types of activities which could be anywhere from post-developmental work to the type of practitioner activity which Dr. Rees talked before, to administration of science or research, et cetera.

Well, when we got all through with this

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what do we have? I think the next slide makes a comparison of our last projection for the total number of doctorates and the one which we come up now.

(Showing slide) On the left in the red field you see essentially what the situation is now.

The situation is that between 1968 and '69 we have the order of 155,000 Ph.Ds and most of those were employed.

Over on the right-hand side in the yellow block, that is essentially what we foresee for 1980.

With the first set of bar graphs representing our previous estimate--and you will see there the one at the left, the checkered one is the supply, and the one which has just the stripes, the diagonal stripes, is the utilization.

When we did this two years ago the supply range, on the basis of various assumptions, seemed to fall right smack in the middle of the possible equalization ranges.

Now when you look all the way to the right you will see that the situation has changed and that if anything, supply is slightly larger than the utilization which we foresee.

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On the other hand, I should add the following: With the kind of uncertainties we are talking about, in either case I think the conclusion would be that the supply is likely to be in balance with the demand. The only difference really between our last projection and this one is that we are a little bit less confident about this now than we were at that time.

(Laughter.)

Now, if one looks at the various areas of science--(showing slide)--you can see this on here. It is the same type of graph with the block on the left-hand always being the supply and the block on the right-hand side being the utilization.

The first set are the physical sciences; next one, the life sciences; the next one, mathematics; the next one, engineering; and the final one, the social sciences.

What you see here-- Let me mention first what one might call the extremes.

In the case of the physical sciences, if anything, these projections might seem to indicate there might be a slight shortage, but it is only slight in that the utilization block is somewhat higher than the

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supply block.

In the case of engineering, on the other hand, there might be a real problem because in engineering the supply seems to really exceed the utilization by quite a bit. And I think this is one field we have got to keep our eyes on very carefully.

The other three, life sciences, mathematics, and social sciences, seem to be roughly in equilibrium. If anything, there might be a slight indication of having the supply exceed the utilization, but, again, I don't think this is very meaningful except to maybe indicate that if things continue to go the way they have been going for the last two years, that that spread might become a little larger and we might have a problem. But at this point I would still say in all three of those that a problem does not seem likely by 1980.

Now, I should put one word of warning in here, and this is especially true about the social sciences. A very large fraction of the doctorates in social sciences are employed by universities and colleges. In fact, I think those were the--that was the highest fraction of any field of science; in the physical sciences, engineering was the lowest one.

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If, by the end of the decade the enrollment in universities starts to go down as they are likely to for demographic reasons because, as many of you know, the birth rate has an effect which will make the college age population start decreasing by about 1978-79 and graduate enrollments will feel this effect by about the '80s and will continue the decrease, by the way, for almost 20 years. In other words, what we are really seeing is, we had the baby boom after World War II and the students we have now in our universities and colleges are the product of that baby boom. But after that the birth rate went down and they won't go up again 'til the children of these students, these baby boom students, will enter the universities again.

Now, if that happens in the early '80s as it is very likely to, then, indeed, one could get into trouble from the point of view of having a balance in social sciences, life sciences and mathematics, and this is especially important because of the lag time, because the students who will be entering graduate school will get their Ph.Ds, let's say in 1981, will be entering graduate schools in 1975-76. But the dropping enrollments of graduate schools through this demographic factor won't

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be felt until about two or three years later and by that time they are well along the way and we might have a little bit of the type of problem which we have now which I won't try to point out that we would have now.

What I am saying now is that we might have a similar situation in the social sciences, mathematics, and the life sciences ten years from now.

Well, these then are our projections. Let me just summarize what they, at least to us, seem to indicate as conclusions.

We still feel that possibly with the exception of engineering, if we look ahead ten years the utilization and the supply will be roughly in equilibrium. We will not have any situation, however, where we will have growth shortages of doctorates.

On the other hand, also if one follows these same projections, it is clear that maybe as many as 25 percent of the doctorates produced between now and 1980 will be in the other type of position which might be a practitioner, your manager, your administrator, your post-development scientist and engineer in industry, and there are many more of them that will be teaching in two- and four-year colleges. This, of course, just

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reinforces what your Chairman pointed out to you before, that this is staring us in the face and there seems to be almost pretty uniform agreement that this will take place from anyone I have seen who makes projections. It really places a very heavy responsibility on the graduate schools to broaden their curriculum, to look into the possibility of non-research and development oriented curricula and, of course, possibly also in degree.

When I use the word "doctorate" here, I am using it in the broadest sense, as a degree which is beyond the master, but it could be a Doctor of Arts, it could be a practitioner doctor, it could be a conventional doctorate.

I think in engineering we have to watch this situation very carefully, especially when the economy swings around again to see whether, indeed, what we project here is likely to happen. And if not, that is the one area where one might want to artificially restrict somewhat the doctorate production.

The final conclusion is probably the most obvious one from just looking at these graphs; namely, that one has to keep on making these projections because the situation we are in now is one in which things are

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changing pretty darn rapidly and what one might project in one year might no longer be valid two years hence, and we intend to do it just as we did here.

Incidentally, all of this will be published in an N.S.F. report which should be out in about two or three months. It takes us at least two months to get it through the Government Printing Office so that's why it takes that long, even though we have essentially finished.

I should warn that the supply projection, if anything, might still be too high because of this feedback effect which I mentioned at the beginning. And if that continues, then these projections on supply, those are the ones I am very leery about because we might just have fewer and fewer students going into the sciences and produce a real shortage situation.

Now, the overall aspect of this I think to me says the following: I think it is important for all of us not to panic just because we are in a period of transition. And if at all possible--and it isn't always--make our decision and plans on the basis of fact and data and not on the basis of the type of anecdotal information which Mike Pelczar read to you or which you

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hear. There is always the story about the Ph.D. who is driving a taxi and got an advanced degree. I have, incidentally, heard about one of such stories recently and when I followed it up it turned out that this Ph.D. was doing this by his own choice. He just wanted to be engaged in some political activities which would take up a considerable fraction of his time. He felt he could not get that time if he would go into a job which really would utilize his doctorate, so he made his living by driving a cab and had more time available. That just illustrates how false and how incorrect anecdotal information can be.

I think we have to watch future developments and, last but not least, I want to echo what your Chairman said. I think the graduate schools and the universities have to be especially innovative in a real creative fashion to be responsive to the needs of society, the needs of the students and to how this situation will develop in the future.